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SAFETY AND EMERGENCY PREPAREDNESS CONSIDERATIONS FOR GEOTECHNICAL FIELD OPERATIONS

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ABSTRACT

The Geo Energy Technology Department at Sandia National Laboratories is involved in several remote-site drilling and/or experimental operations each year. In 1987 the Geothermal Research Division of the Department developed a general set of Safe Operating Procedures (SOPs) that could be applied to a variety of projects. This general set is supplemented by site-specific SOPs as needed. Effective field operations require:

- integration of safety and emergency preparedness planning with overall project planning,
- training of field personnel and inventorying of local emergency support resources,
- and, developing a clear line of responsibility and authority to enforce the safety requirements.

Copies of SOPs used in recent operations are included as examples of working documents for the reader.

KEY WORDS: geoenergy, geothermal field operations, safety: planning, integration, training; emergency preparedness

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BACKGROUND

The Geo Energy Technology Department (6250) at Sandia National Laboratories is involved in remote-site drilling and/or experimental operations. In 1987, the Geothermal Research Division of the Department recognized the need for a general set of Safe Operating Procedures (SOPs) that could be applied to a variety of projects. A general set was developed that could then be supplemented with site/project-specific SOPs as addenda. Other documents such as emergency action summaries, maps for evacuation and Forest Service regulations can also become addenda.

Operations at geotechnical sites may involve:

- powerful machinery that rotate and lift heavy hardware overhead,
- considerable electrical power,
- steam/hot fluids vented from the geologic formation,
- hot surfaces on pipe, downhole tools, and other hardware periodically brought to the surface,
- lethal concentrations of formation gases,
- simultaneous on-site operations by personnel from several companies/national labs/universities,
- shared equipment and various well logging techniques that may require high voltages and explosives,
- and, 24-hour per day operation (usually two 12-hour shifts) for several months.

The potential for accidents and serious injury is present. General SOPs have been prepared by the Geothermal Research Division for: General Field Work, H_2S Monitoring and Emergencies, Shared Operations, and Access Control.

Preparation of an SOP package forces the project personnel to consider the potential hazards, the consequences of unsafe practices, emergency procedures, and to develop a "safety consciousness" that can reduce the risk of injury.

The purpose of this document is fourfold:

1. Provide examples of integrating safety planning with overall project planning for future Department 6250 field operations.
2. Identify safety areas unique to field operations and suggest methods of resolving problems.

3. Provide sample documents to illustrate the coordination and preparation necessary for field operations.

4. Raise the safety awareness level of Department 6250 personnel involved in field activities.

BASIC PHILOSOPHY

Several basic tenets drive the safety philosophy:

- Safety is a basic ingredient of the project, not just a corporate requirement.
- Remote locations are "special cases" that require a high level of safety and emergency preparedness awareness and planning.
- Safety professionals should be involved in the initial planning and become contributing members of the project team.
- Project personnel will embrace the safety plans if the plans are reasonable and flexible; and if safety is promoted as a logical concern for the common welfare.
- Perceptions of safety issues by project personnel may vary due *to* personalities, technical disciplines and experience bases. Perceptions are real and must be dealt with if they are counter to good safety practice.
- A composite project group (SNLA, other labs, contractors, universities, etc.) at a remote site requires close coordination on safety issues. One institution must be designated as the lead on safety and a clear line of authority established.
- Adequate training of site personnel is absolutely essential and helps to develop proper safety attitudes.
- Real-time field decisions on safety issues usually have to be made by the field safety coordinator, and the authority to make those decisions must be delegated by management.
- Management must be willing to staff an operation adequately so that long shifts and fatigue do not become causative factors in accidents.

This basic philosophy is incorporated into the project from the planning stage through the project conclusion. Typical project phases included in safety considerations are:

- contractor negotiations,

- personnel selection and assignment,
- equipment mobilization.
- start-up (a particularly critical time as various groups of people begin working together under operational conditions),
- continuing operation (familiarity and routine may lead to lapses),
- and, demobilization (this is another critical time since people are anxious to tear down and leave the site to return home.)

SAFETY PLANNING, IMPLEMENTATION AND MONITORING

Planning

Planning for safe operation of a geotechnical field operation should include the costs of personnel time (project personnel, in-house service organizations such as Safety, Environmental Health and medical groups and other support staff) needed to deal with safety issues as well as the obvious budgetary considerations for safety equipment and contractor support for specialized services. Project personnel should be chosen according to good management practices (interest, experience, availability, etc.), but also with consideration of their safety attitude.

Management must be willing to delegate a level of authority to the field safety coordinator that is in direct proportion to the responsibility placed on the coordinator. Recognizing that remote operations are unique, management cannot expect to always be consulted in every decision; therefore, seasoned personnel should be chosen for critical field positions and be given latitude to address unforeseen safety issues within the framework of the project safety philosophy.

Working interfaces regarding safety must be established. Other national labs operating under DOE rules and regulations could be expected to operate in a similar fashion to SNLA. However, university and contractor personnel may not be as well indoctrinated in safety practices. It is essential that representatives from all concerned organizations be involved in early project meetings and that safety be one of the primary concerns discussed. Clarification of responsibility and authority for site safety implementation is an important subject at this point.

Implementation

Administrative controls (procedures, signs, visitor logs, etc.) are emplaced at the site as soon as there is appreciable activity. The need for special protective equipment should be anticipated ahead of the actual need and be on-site and in working order. Personal protective equipment (safety glasses, safety shoes, hard hats, etc.) shall be worn as required.

Attitudes regarding safety can be shaped by project leaders and safety coordinators modeling the behavior expected from other site personnel. Appeals to common sense, basic good judgement, and teamwork in training sessions adds to the shaping of attitudes. Using competent, experienced instructors in first-aid, cardiopulmonary resuscitation (CPR), and self-contained breathing apparatus (SCBA) training sessions reinforces the impression that safety will be treated seriously on the project. Anyone with operational responsibilities at the site is required to read the SOPs and verify by signature that they understand and will abide by the safety requirements.

Physical barriers may be needed to remind site personnel of certain hazards as well as to prevent visitors from entering high risk areas. Casual visitors will always be escorted by site personnel if access to an active working area is required. The drill rig foreman always has veto power for requests for access to the rig floor. Concentric zones defining controlled areas with higher risk near the center may be established with either soft or hard barriers, as appropriate.

The site safety coordinator must have the recognized authority to discipline anyone on the site for safety lapses. Willful disregard of the safety rules or continued inadvertent lapses are sufficient cause to ban someone from the site. The safety coordinator should make a reasonable effort to resolve the problem before taking drastic action against the offender. This attempt at resolution may involve the foreman of the drilling crew, a senior scientist, the project leader, or any other authority figure on site.

Monitoring

Periodic monitoring to see if safety rules are being followed is essential. This is done by the safety coordinator on a daily basis in the course of the project, as well as a periodic basis by other project personnel. Occasional random checks by Safety, Environmental Health, and Fire Prevention professionals are valuable because an outsider's view is not colored by familiarity. As the project progresses, additional safety issues may need attention and new procedures can be considered addenda to the original SOPs.

EMERGENCY PREPAREDNESS

Safety planning, training, implementation and monitoring can reduce the probability of an accident or injury occurring; however, the probability can never be reduced to zero. Therefore, an emergency preparedness plan must be developed and emplaced at the site. Site personnel must be informed and trained in execution of the plan and off-site responders must be aware of the planning for emergencies.

Off-Site Emereency Resources

Geotechnical operations may be located in remote areas where emergency services are available, but the response time to the site can be lengthy due to several factors. Most emergency medical service (EMS) systems in small towns are staffed by dedicated volunteers that are alerted by the EMS system and then respond to the fire station to get the necessary equipment before they start to the scene. Some areas do have volunteers equipped to respond from their homes/job locations and at least provide first-responder evaluation and stabilization of victims. Access to a remote site is usually over rough roads that may require 4-wheel drive vehicles and this can impact response time.

Assessing the local resources and response times in the event of an emergency is one of the first considerations in developing an emergency preparedness plan. This can be done by visiting the local fire station, police department, medical clinic/hospital or town hall. Meeting and talking with these people and establishing a working relationship and trust (remember, the project and its personnel are "outsiders") is very important to efficient activation of these people if the need arises. It is extremely important to brief them on the location of the site, potential injuries, site-specific hazards, etc. The following points illustrate the coordination necessary at the Inyo 4 operation at Mammoth Lakes, California, in 1987:

- All site personnel were trained in CPR, first aid, and the use of SCBAs. Emergency equipment to support this training was on-site.

- The hospital assistant administrator was visited and briefed on the type of injuries that could potentially occur. Hospital files were checked for H_2S treatment protocol.

- The fire department paramedics were visited to discuss the site operations, It was noted that self-contained breathing apparatus (SCBAs) are not normally carried on the rescue vehicle, but rather, on the fire truck. The paramedics then changed their equipment inventory to include the SCBAs for any response to the drill site. They were also informed about the level of training of site personnel in first aid, CPR, and SCBAs and what medical equipment was available at the site.

- Site visits were arranged for the hospital administrator, the fire chief and the senior paramedic. Staging strategies for emergency vehicles approaching the site (a steep climb of several hundred yards on a primitive, one-lane road with little room to turn around at the site) were established so that the egress of first arrivals was not blocked by later arrivals.

  (Comment: The only serious injury incurred on this project was a nearly severed finger by one of the drilling crew helpers as he used a hatchet to taper a wooden stake.)

Another site operation that can be used as an illustration of emergency preparedness planning is the VC-2B operation near La Cueva, New Mexico, in 1988 :

- All site personnel were trained in CPR, first aid, and the use of SCBAs. Emergency equipment *to* support this training was on-site.

- The police chief of Jemez Springs, New Mexico, was contacted and briefed on the site operation. Equipment resources and skill levels of the volunteer paramedics were reviewed at the police/fire station.

- A volunteer paramedic living within one mile of the site was designated as first-responder, if available. This individual was briefed about site operations, potential hazards, and emergency preparedness planning.

- Regional medical facilities identified were the clinic at Jemez Springs and the hospital at Los Alamos, New Mexico, (the clinic is not open every day and the hospital is approximately 45 minutes away by vehicle).

- A considerable amount of time was spent arranging for medical evacuation of victims with life-threatening injuries from the site. LIFEGUARD Helicopter Services in Albuquerque were contacted and briefed regarding the site operations. A "special scene" form was filed with the LIFEGUARD office (a copy of the form is carried by the aircraft) and the chief pilot made a visit by ground vehicle to the site to choose primary and alternate landing zones. Radios were obtained that permit site personnel to talk with the inbound helicopter. The helicopter response time from Albuquerque is approximately 25 minutes and it carries two trauma nurses and a sophisticated assortment of emergency room equipment.

  Activation of the LIFEGUARD system includes activation of volunteers from Jemez Springs so that the victim will receive advanced medical treatment even if the helicopter is unable to land due to weather conditions or mechanical problems.

  (Comment: Two injuries occurred at this site. One involved a SNLA employee who burned the palm of his hand on a hot surface. The other situation involved a drilling contractor employee who slipped and fell against a piece of structure, severely bruising a kidney.)

One final example of emergency planning for remote site operations is that required for testing downhole tools at a commercial rock quarry approximately 20 miles west of Belen, New Mexico. This site is occasionally used to check various systems before going to an operational site.

- First aid and CPR training was required for all SNLA personnel working at the site. Emergency equipment to support this training is on site.

- The hospital location in Belen was described in the SOP.

- Mobile telephones were obtained for the site crew.

- Arrangements were made with LIFEGUARD Helicopter Services to support the site in the event of life-threatening injuries. Again, a "special scene" form was filed and is carried on the aircraft.

- Access to the site involves using a primitive dirt road that can become very muddy; therefore, 4-wheel drive vehicles are required.

- The site is located on a mesa top with considerable exposure to severe weather conditions; therefore, operations are restricted during lightning or wind storms.

On-Site Emerzencv Resources

The key to the proper on-site response to emergencies is well-trained site personnel. The proper equipment must also be available for use. A well-equipped trauma kit, a backboard, and supplemental oxygen are basics. SCBAs for rescue and shutting down the drill rig in the event of a toxic gas release are also on hand. Initial training in first aid, CPR, and the use of all emergency equipment is given to all site personnel with operational responsibilities prior to start-up. Periodic refresher classes and training of new people coming on site to work is also scheduled.

(Comment: Several comments have been made by site personnel indicating that the training was appreciated and that the quality of the training and the competence of the instructors was excellent. Some workers would take the initiative to practice and refresh their memory on certain emergency procedures at slack times in the operations.)

A communication center is established at the site and succinct procedures are posted at the center for emergency use. Telephone lines are not always available or if available, not reliable, so radios on several nets are provided. these nets may be the Forest Service, private landowners, a local emergency organization, or a special net established by the site personnel with communication to the motel where the off-shift crew is headquartered.

Evacuation plans are required for sites having the potential for toxic gas release. Evacuation plans vary depending on the wind direction, day or night situations, etc. A regrouping area is designated for each scenario so that a head count may be taken.

Periodic tests of emergency equipment and gas sensing systems are necessary. Every effort is made to resolve and eliminate false alarm problems so that the entire site crew has confidence in the systems. Also, emergency drills are held at slack times to check the response of the site crew.

Post-Emergency Critiaue

This critique of any emergency action that is taken serves to improve on the emergency plan as well as to give site personnel an opportunity to have additional input into the plan. Hindsite tends to be 100% correct where foresight is seldom 100%. The important point here is that the emergency plan can be improved by a review and frank discussion following the emergency.

APPENDICES

Appendix A is a typical sequence for integration of safety and emergency preparedness planning into field operations.

The SOPs contained in Appendix B are copies of documents used in recent field operations. These documents are intended to be helpful examples to those who may be required to prepare field SOPs for remote site operations.

Appendix C contains a pictorial display of typical activities from several sites that have been discussed in this report.

ACKNOWLEDGEMENTS

The author wishes to express appreciation to several individuals: R. D. Jacobson and P. C. Lysne, both assigned to the Geothermal Research Drilling office of the Geothermal Research Division, played key roles in developing and implementing the philosophy and guidelines of this report in several field operations; Gwen Gorman, Sue Armstrong and Elaine Squyres from the SNLA Medical Department have been willing to provide CPR and First Aid training at remote sites under non-traditional circumstances; likewise, the Safety and Environmental Health Department has supported the field operations on a timely basis with specialized training and equipment.

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APPENDIX A

TYPICAL SEQUENCE FOR SAFETY INTEGRATION WITH PROJECT PLANNING AND OPERATION

a. Arrange for site visits as early as possible to scout the area for site-related hazards (power lines, cliffs, rock falls, slides, hazardous gas fumaroles, etc.) that impact safety planning.

b. Identify common potential hazards present in field operations.

c. Establish a lead group and a line of resoonsibilitv for safetv planning and implementation.

d. Identify uniaue potential hazards present in this type of field operation.

e. Locate equipment/services necessary to support safe operation.

f. Identify personnel with proper interest, background, and availability to support the operation.

g. Involve professional safety and environmental health personnel in the planning, specialized equipment acquisition, and project support process.

h. Develop a preliminary estimate of costs involved in safety and emergency preparedness activities.

i. Meet with project leader(s) to make sure budgeting is adequate to cover safety needs.

j. Management and project leader(s) should clarify to all project personnel that safety is to be taken seriously.

k. Order special equipment having long delivery times well in advance of the need to allow time for checkout, installation, and training.

1. Arrange for training of on-site project personnel in the use of first aid, CPR, SCBAs, etc.

m. Continue to emphasize safety as one of the primary project concerns at each opportunity in project meetings.

n. Generate SOPs, emergency preparedness procedures, instructions, etc, and continue to refine the documentation. When ready, obtain necessary approvals on documentation.

o. During mobilization, emplace the safety package and equipment in a positive manner to demonstrate the concern of SNLA regarding safety issues.

p. Initiate administrative and physical controls to limit access to necessary personnel.

q. Arrange for necessary calibrations, certifications, etc., of safety equipment.

r. Complete any on-site training required.

s. At start-up, monitor operations for an appropriate period of time to see if safety requirements are being followed.

t. Continue to regularly monitor operations until project completion, noting when new personnel come on-site and assure that proper briefing and training in safety matters is given.

u. Document any safety issues that arise, and if needed, develop new or revised procedures.

v. At demobilization, assure that appropriate safety procedures still are being followed until the site is vacated.

w. Recover all safety hardware and equipment and repair, replace and/or store as appropriate for the next operation.

x. Return visits to the site over a period of years may be required to perform well logging, perforation, environmental restoration, etc. some of these activities may require additional safety planning and implementation.

APPENDIX B

EXAMPLES OF SOPs USED IN RECENT FIELD OPERATIONS

- Geotechnical Field Work
- Baca Flats Operations (Specific)
- Operations shared by SNLA/Other companies at Geotechnical Sites (Specific)
- Access to Rig Floor and Rig Perimeter at the Baca Flats Drill Site (Specific)
- Potential H_2S Emissions (General)
- Potential H_2S Emissions at the Baca Flats Drill Site (Specific)
- Scientific Core Hole VC-2B: Fire and Ecological Damage Mitigation Plans
- Air Emergency Services (Lifeguard)

SAFE OPERATING PROCEDURE
for
ORGANIZATION 6240 GEOTECHNICAL
FIELD WORK
(GENERAL)

R. K. Traeger - 6240 — Date 5-21-87

J. C. Dunn - 6242 — Date 5/22/87

J. R. Doyle - 3315 — Date 5/22/87

K. K. Miles - 3315 — Date 5/22/87

PREPARED BY:

R. P. Wemple - 6242 — Date 5-20-87

GENERAL SOP FOR ORGANIZATION 6240 GEOTECHNICAL FIELD WORK

APPLICATION

The general philosophy and requirements of this SOP are intended to apply to a broad range of applications. Department 6240 is involved in various field activities related to geotechnical research. Typical activities include, but are not limited to: geophysical surveys prior to a drilling operation, on-site instrumentation and control of surface and dovnhole devices, developing drilling strategies, overall drill-site coordination, interfacing with scientists from government/university groups, and follow-up well logging with unique, state-of-the-art instruments.

PHILOSOPHY

This SOP is structured to be general in nature and to point out a number of situations where potential hazards could arise in field work involving geotechnical experiments. Site-specific and/or operation-specific situations requiring greater detail on potential hazards will be developed as separate addendums and appended to this general SOP. The signatures of all users and the appropriate management approvals should appear on the general SOP and on all appended documents to signify awareness of, agreement with, and commitment to comply with the content. The SOP should cause the users to think about the potential hazards and then to operate in such a way as to minimize the risk without causing unnecessary frustration in conforming to the SOP. An SOP cannot prevent injury to the users. Only the users themselves can minimize the risk of injury by conscientious attention to the situation and awareness of the hazards.

Nanauement Expectation and Delegated Authority - Management expects the users to demonstrate a certain level of personal responsibility in conforming to the SOP; however, a certain measure of delegated authority must accompany the expectation of responsibility. The discretion necessary in using this delegated authority must be agreed to by both management and the personnel involved. Examples of the use of this authority could be: shutting down an operation and excluding all personnel until unanticipated results are understood, observation of unsafe practices by a co-worker and immediate notification of management if unable to diplomatically resolve the problem, asserting oneself in the face of pressure to complete a test on schedule by taking certain unsafe shortcuts, etc.

POTENTIAL HAZARDS

Field work contains a variety of potentially hazardous situations. Examples are: large powerful machinery that rotate and lift heavy hardware, considerable electrical power to run the

machinery, toxic gases, steam and hot fluids vented from the geologic formation by the drilling operation, hot surfaces, simultaneous on-site operation6 by personnel from several companies, shared equipment, well logging operation6 involving high voltages, the use of explosives, etc.

All on-site personnel must be made aware of the potential hazard6 and the proper responses to any emergencies that might occur in spite of the physical and administrative controls imposed by the SOP.

Non-SNLA personnel (well sitters, core loggers, etc.,) from other laboratories and universities frequently spend considerable time on-site. These individuals should be required to read and signify by signature that they understand and will abide by the requirements of the SOPs.

Management must be sufficiently aware of the field workload to adequately staff an operation 60 that long shifts and fatigue do not become causative factors in accidents. Proper responses to emergency situations can be impacted by fatigue.

RESPONSIBILITIES AND PERSONNEL ASSIGNMENTS

Clear-cut lines of responsibility must be established prior to starting a field operation. If teams are established with multi-disciplinary backgrounds and different level6 of field experience, it is particularly important to assure that each team member understands hi6 responsibility and the limits of that responsibility. Selection of a particular team should be based on good management practice of utilizing talent, experience, interest, and attitude. Briefings should be conducted, as appropriate, by the team leader to advise all personnel of significant changes in procedure. particular problems that have arisen, anticipated problems for their shift, and any other information that impacts safe operation. All personnel should be encouraged to ask questions about things that they perceive to be safety problems. Perceptions are real, although the problems may not be.

Operation6 involving personnel from several companies need particular attention to assure that appropriate safety issues have been addressed. Ideally, joint agreements regarding safety planning should be in writing, although practically, real-time field agreements may be difficult to negotiate in writing. Agreement6 may be simple lists of concerns or more complicated definition of responsibilities. A document of this sort should be appended to this general SOP.

EXCLUSION AREAS

Exclusion area6 shall be established, as appropriate, to exclude non-essential personnel. Breaching of the barriers will be

considered a violation of the safety guidelines. Proper respect for the barriers reinforces the seriousness with which SNLA treats safety and sets an example for the non-SNLA workers at the site. The division of turf and responsibility at remote site occupied by various personnel is recognized as a delicate **subject** but that division must be as clear as possible and continue to be clarified as problems arise.

PERSONAL PROTECTIVE EQUIPMENT

Appropriate personal protective equipment will be used by the operating personnel. Hard hats, safety shoes, and eye protection is the most basic protective equipment. Spare equipment shall be available at the site for visitors requiring entry to areas requiring protection. Additional special protective equipment may be required by the site-specific safety plan.

EMERGENCY PREPAREDNESS

Providing a site-specific emergency preparedness plan is an essential part of this SOP. The emergency planning document should contain a discussion of the logic pertaining to an emergency response as well as details of specific issues. The emergency resources available in a region must be ascertained. An appropriate means of communication within the test site and external to the site should be available and tested periodically. If external radio or telephone communication is not available due to geographic features or remoteness of the test site, a reliable vehicle must be readily available for use in emergencies. A "critical actions" list must be posted in the control area and clearly identified as such. The emergency preparedness plan should be appended to this SOP.

Appropriate emergency equipment should be available at the test site with an industrial first-aid kit as a minimum. Also, personnel should be trained in the proper use of whatever equipment is deemed necessary.

Basic training in first-aid and CPR techniques shall be provided for all SNLA Org. 6240 personnel regularly participating in field tests. Other companies/institutions participating in a field operation are responsible for assuring that their personnel are properly trained and equipped.

PROFESSIONAL CONDUCT

Professional conduct in keeping with the SNLA Code of Conduct by SNLA personnel at all times while on-site and operating under the safety guidelines is absolutely essential. Therefore, practical jokes or other activities that even remotely affect safety will not be tolerated. The professional integrity of SNLA as an organization can be undermined by inappropriate behavior.

CONTINUING AWARENESS OF HAZARDS

It may not be possible to identify all significant hazards before beginning a geotechnical field operation. Therefore, it is important that all operating personnel be continually alert to safety concerns that may develop. This general SOP may be appended at any time with additional information.

AUTHORIZED PERSONNEL

Signatures on the Site Signature List signify that the authorized personnel have read and agree with the content of this SOP and all appropriate addendums and will abide by the requirements.

SOP# 12301.8804
Division 6252

Addendum to
SOP #12300.8705

Safe Operating Procedure
for
Baca Flats Operations
(Specific)

R. K. Traeger, 6250 — Date: 6-28-88

J. C. Dunn, 6252 — Date: 4/28/88

D. R. Parker, 3311 — Date: 6-28-88

D. Y. Joe, 3316 — Date: 6/28/88

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Prepared by:,

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SITE-SPECIFIC SOP FOR BACA FLATS (VC-2B) OPERATIONS

GENERAL

The Baca Flats (VC-2B) drilling operation is another in a series of coring programs in Valles Caldera, NM, to better understand the geologic formation at depth. Complete core recovery to a slant depth of approximately 6000' is the goal of the program.

The potential hazards associated with any drilling operation will be present. In addition, toxic gas (H_2S) occurs in local formations and it may be liberated by the drilling operation. Furthermore, formation temperatures may exceed 300°C, so hot, boiling fluids may be produced by the hole.

The drilling site is located approximately six miles from La Cueva, NM, and it is on private property owned by the Baca Land and Cattle Company. Access is controlled by a locked gate. Telephone and radio communications are available. The nearest dwellings are at Sulfur Springs and they are located about 1/2 mile from the Baca Flats site (Sulfur Springs is the location of a previous GRDO operation).

Major equipment at the site will include the drill rig operated by Tonto Drilling Co., well blowout equipment, storage trailers, an RV used as an office/control center belonging to Sandia National Labs, an office trailer, and several pickups and other vehicles used for access.

Personnel at the site at various times could include but are not limited to those from: Tonto Drilling, Sandia, LANL, UURI, USGS, DOE, and various universities.

A summary of all emergency actions and the appropriate directions to the hospital, personnel to notify, etc., will be posted in a prominent location in the office/control center.

SITE SUPERVISION AND ACCESS CONTROL

The responsibility for on-site activities for the Baca Flats Drilling Project have been assigned to Sandia/GRDO by the DOE/OBES through the Drilling Project Management Plan. Specifically, site management and site safety are the responsibility of P. Lysne or his alternates, R. Jacobson or A. Sattler. One of these individuals will be on site or in the vicinity during most major activities such as drilling. Occasionally and for short periods of time, the Site Manager may designate J. Gardner (LANL) or J. Hulen (UURI) to act on his behalf.

The Principal Scientific Investigators, J. Gardner and J. Hulen are responsible for the well sitters who are all LANL employees. The well sitters are an integral part of the safety team and they will be responsible for implementing the safety plan if the Site Manager or his delegates are not on site.

The drilling foreman, L. Pisto (day) and R. Fireback (night) have primary responsibility for safety in the immediate vicinity of the drilling rig and per the operating procedures of Tonto Drilling Company of Salt Lake City.

The Environmental Health advisor(s) will be B. Kelly, or E. Sanchez, Organization 3311.

Safety advisor(s) will be: D. Joe, Organization 3316.

Access control for the site requires that all visitors to the site check in at the office/control center. Depending on the responsibilities of the visitor, the Site Supervisor can elect to give a safety briefing. The visitor's signature and the date of the briefing will signify the visitor's awareness and intention to comply with the safety procedures.

EMERGENCY PREPAREDNESS

The H_2S Health Hazard Information, Training, and Emergency Response information is the responsibility of SNLA Industrial Hygiene/Toxicology Division 3311.

Overall Safety approval for the site SOPs is the responsibility of SNLA Safety Engineering Division 3316.

FIRE PREVENTION

While the site is on private property, fire prevention procedures will follow those applicable to National forest lands. The appropriate procedures are attached to this addendum.

EMERGENCY ACTION SUMMARY

STAY CALM! GIVE PRECISE INFO TO OFF-SITE CONTACTS!

Assessment of the Situation - Essential for the proper emergency response.

H_2S problem? Accident? Injuries? Fire?
Evacuation/Rescue necessary? Move victim? Don't move victim?
Off-site assistance required? Tansportation to medical facility by site personnel required.
What are your current on-site resources? (personnel, equipment, vehicles, etc.)
What communication links are operational?
What other factors influence your decision? wind direction, etc.?

MAKE YOUR DECISION(S) AND ACT!!

Communication-Necessary to get off-site help or to alert the hospital of victim(s) being transported.

Radio links:	Sandia radio (call sign: VC-2B, (Fenton Hill Net is accessed)
Baca Owners net:	Radio On-Site
Aircraft: radio	Lifeguard Helicopter frequency marked on radios
Telephone:	FIRE DEPARTMENT; 829-3345 (Jemez Springs) AMBULANCE: 829-3345 (Jemez Springs) SHERIFF: 867-2375 (Bernalillo) FOREST SERVICE: 829-3535 (Jemez Springs)

Hospital Location-Los Alamos
Hospital: 662-4201
Ambulance: 662-4325

Directions: You will be entering Los Alamos on Jemez Rd. Drive past LANL administration building and turn left at first stop light (Diamond Rd) cross bridge. Hospital second building on right.

Lifeguard Helicopter
1-800-MED-LIFT
l-800-633-5438

TRY TO STAY CALM!
GIVE PRECISE INFORMATION TO OFF-SITE CONTACTS!
DRIVE SAFELY!

HYDROGEN SULFIDE SAFETY PLAN
FOR
BACA FLATS OPERATIONS

Alarms: ASSESS THE SITUATION. NOTIFY SANDIA REPRESENTATIVE.

* Red Liaht: Comes on when hydrogen sulfide is a above 10 ppm. No immediate danger, but be very cautious when entering a confined space such as the cellar or mud tank. The hole should not be advanced unless approved by the GRDO Site Manager or the drilling Foreman. Rotation and/or circulation may be maintained.

* Audible Alarm: Sounds when there is 20 ppm of hydrogen sulfide. The site should be shut down immediately and personnel should leave the area in the up-wind direction from the rig. Remedial operations must be approved by the GRDO Site Manager.

Everyone on-site should:
* Know the location of the Scott Air Packs and first-aid supplies.
* Look at the windsock occasionally.
* Know the important phone numbers.

In Case of an Emergency Situation:
* Know wind direction-check windsock.
* People not involved should leave the site.
* Scott Airpacks (buddy system) to be used to correct problem.
* Don't become an additional victim.
* If there is a victim:
  2-man plan--Assess the situation to either begin CPR or take to the hospital if victim is conscious.
  3 man-plan--One person perform CPR on victim, if necessary: the other person drives to the hospital. Stopping the vehicle during the trip may be necessary to permit proper CPR to be evaluated if the road is rough.

For Very Large Emissions of Hydroaen Sulfide:
* Warn and evacuate all nearby downwind people.
* Call Sheriff's Dept.

Confined Space Entry:
* Use "buddy system"; use "trouble signs" communication system.
* Check continuous monitors.
* Inform others that a confined space is being entered.
* Ventilate area with a blower for an appropriate period.
* Use the hand-held monitor(s), holding it in front of you as you walk.

REITERATION OF PROFESSIONAL CONDUCT

The parent SOP emphasizes the importance of Professional Personal Conduct by all site personnel. This paragraph is added to underscore, AGAIN, the importance and to specifically call attention to certain items.

People from several companies are on-site, the project has a high-visibility nature, and environmental concerns are very real. Safe operation is essential, and a very small breach of professionalism or a safety lapse could have far ranging consequences.

As a consequence, the following items are banned from the drillsite.

- Guns
- Illegal weapons of any kind
- Alcohol
- Illegal drugs and substances
- Fireworks
- Other items as deemed inappropriate by the Site Supervisor

Anyone found in possession of these items or under the influence of any judgement-altering substance will be banned immediately from the site, until the situation is reviewed and action is taken.

VEHICLE CONSIDERATIONS

The road to the site has a 25 mph limit from the paved road to the site. A family with children and pets lives at Sulfur Springs. Logging trucks may be using the road before the drilling operation is completed. The site is located on private property and access is through a gate that is to be locked at all times, unless otherwise arranged.

The above information should be sufficient to cause all site personnel to obey the rules and drive safely when entering or exiting the site. The Site Supervisor may restrict the driving privilege of those ignoring this safety caution.

AUTHORIZED PERSONNEL

Signatures on the Site Signature List signify that the authorized personnel have read and agree with the content of this and other SOPs and all appropriate addendums and will abide by the requirements.

SITE SIGNATURE LIST

The following person(s) acknowledge by signature that they have read the site safety requirements, understand their responsibilities, and will abide by the requirements:

NAME	ORGANIZATION	DATE

SOP# 12100 8705
Division 6242

SAFE OPERATING PROCEDURE
for
OPERATIONS SHARED BY SNLA/
OTHER COMPANIES AT
GEOTECHNICAL TEST SITES
(GENERAL)

R. K. Traeger - 6240 — Date: 5-21-87

J. C. Dunn - 6242 — Date: 5/20/87

J. R. Doyle - 3315 — Date: 5/22/87

R. K. Miles - 3315 — Date: 5/22/87

PREPARED BY:

R. P. Wemple - 6242 — Date: 5-20-87

GENERAL GUIDELINE SOP FOR OPERATIONS SHARED BY SNLA/OTHER COMPANIES AT GEOTECHNICAL TEST SITES

General

Shared operations have the potential for miscommunication, unclear lines of responsibility/authority, and the end result of an adversarial relationship between participating personnel; i.e., scientists, visitors, contract workers. The intent of this general SOP is to Clarify some of the issues and to impose procedures to avoid some of the problems.

Each participating institution has its own method of operation based on the task to be performed. Also, the operating staff of each institution ha6 certain talents, skills, and personal preferences in completing their task. It is the meshing of these policies and personal preferences that will develop and implement joint safety guidelines. A single overall site officer representing the Legal Operator of the site Shall have the authority to make real-time decisions.

OBVIOUS HAZARDS

Obvious, significant hazards will be recognized by all personnel. It is likely that responses to potential emergencies caused by those hazards will be similar but differ somewhat based on different experience bases.

SUBTLE HAZARDS

These may be discovered by site personnel and pointed out to others. If everyone has respect for each other, a sense of appreciation will be developed for the "other guy" watching out for "my welfare. "

INTERMEDIATE HAZARDS

These are hazards/situations identified by one person or group but not fully accepted a6 such by Others. Judgement on these issues may be colored by experience, emotion, financial penalties, personality conflicts, fatigue, etc. These issues have the potential for severe conflicts between personnel. A method of resolving these potential conflict6 must be agreed to prior to beginning operations. Exclusion area boundaries can help to define physical areas of responsibility. However, when actions within a boundary can affect personnel in other areas, some means of resolution must be available. As previously Stated, but repeated here for emphasis, a single overall site officer representing the Legal Operator of the site Shall have the authority to make real-time decisions.

LEGALITY

It is not the intent of this SOP to influence any legal positions or responsibilities of SNLA. This document is only to be used as a guideline for development of working documents and agreements that may be needed between SNLA and others sharing a geotechnical field site.

AUTHORIZED PERSONNEL

Signatures on the Site Signature List signify that the authorized personnel have read and agree with the content of this SOP and all appropriate addendums and will abide by the requirements.

SOP# 12101 8806
Division 6252

Addendum to
SOP #12100.8705

Safe Operating Procedure
for
Access to Rig Floor and
Rig Perimeter
at the
Baca Flats Drill Site
(Specific)

R. K. Traeger, 6250 — Date: 6-28-88

J. C. Dunn, 6252 — Date: 6/28/88

D. R. Parker, 3311 — Date: 6-28-88

D. Y. Joe, 3316 — Date: 6/28/88

D. L. Rost, 3316 — Date: 6-28-88

Prepared by:

P. C. Lysne, 6252

The Baca Flats Program is a scientific venture to explore a hydrothermal zone of the Valles caldera by drilling. It is imperative that the scientific data not be compromised by unnecessary rules and regulations. At the same time, it must be recognized that the project contains inherent dangers and these dangers are greatest in the vicinity of the drilling rig. The procedures documented herein limit, but do not exclude, access to danger areas by scientific personnel. While the GRDO has overall responsibilities for site safety: it delegates the responsibility of implementing this portion of the safety plan to the Tonto supervisor who is in charge of the rig floor and rig perimeter.

The drilling rig is normally crewed by a foreman, a driller, and at least one helper. Other persons involved in rig activities may include the mud technician and other support personnel for operations such as water delivery, cement pumping, excavation, etc. The rig and surrounding area is busy with powerful rotating machinery, large electrical power systems, long heavy lengths of drill pipe and casing, overhead hoists, etc. Also, in geothermal drilling, hot surfaces and steam plumes may be present. Safety shoes, hard hats, and eye protection are the basic personal protective equipment required in this area: additional special equipment may be required.

It is imperative, therefore, that all non-essential personnel be excluded from the rig and the surrounding work area for both safety and operational reasons. The following outline clarifies the access rules for the rig floor and the rig perimeter.

A. Rig Floor

- Person in charge; Tonto Supervisor
- Normal access: Principal Investigators (J. Hulen and J. Gardner) and GRDO staff.
- Access in unusual conditions at discretion of the Tonto Supervisor.
- Others by escort.

B. Rig Perimeter (designated by ropes with a minimum distance from the rig of a rod stand plus the elevation of the rig floor ≈ 50').

- Person in charge: Tonto Supervisor
- Normal access: Principal Investigators, GRDO and well sitters
- Access in unusual conditions at discretion of the Tonto Supervisor
- Others by escort

SOP# 12200 8705
Division 6242

SAFE OPERATING PROCEDURE
for
GEOTECHNICAL SITES WITH
POTENTIAL H_2S EMISSIONS
(GENERAL)

R. K. Traeger - 6240 — 5-21-87 Date

J. C. Dunn - 6242 — 5/22/87 Date

D. R. PARKER - 3311 — 5-21-87

J. R. Doyle - 3315 — 5/22/87 Date

K. K. Miles - 3315 — 5/20/87 Date

R.O. RIVERA - 3311 — 05/21/87

PREPARED BY:

R. J Wemple - 6242 — 5-20-87 Date

GENERAL SOP FOR GEOTECHNICAL FIELD SITES WITH POTENTIAL H2S EMISSIONS

GENERAL

Geotechnical sites often have hydrogen sulfide(H2S) gas present in the geologic formation. Sometimes this gas can be detected at the surface (a rotten-egg smell) even before exploration or drilling begins. This gas can be fatal when inhaled in relatively low concentrations. Immediate medical treatment is necessary if a person is overcome. Emergency breathing apparatus should be available on-site for use in escaping a large, unexpected release and/or for entry to an area where emergency work must be performed.

SENSING AND ALARM SYSTEM

An appropriate sensing and alarm system must be available prior to any significant amount of field work. SNLA Industrial Hygiene/Toxicology Division 3311 will establish the need, provide proper equipment/training/procedures, and monitor compliance with this SOP. Initial and periodic testing/calibration of the sensing system is required. The system may consist of both fixed-position and portable sensors, or in simple operations could encompass only portable equipment. Detail6 of the sensing system and persons to contact in case of malfunction Shall be included in the site-specific SOP and posted in the control area.

The sensing system shall have two alarm levels (low and high). The ppm concentrations for these alarm levels shall be dictated by Division 3311. Each level Shall have a unique audible/visual alarm that can be heard/seen from prominent locations at the site. A wind sock Shall be installed in the most favorable location at the site to indicate surface wind direction.

RESPONSE TO ALARMS

Each time that the alarm system triggers, the on-site personnel must assume that the alarm is valid and react properly. The proper response may vary depending on the situation (i.e.. alarm level, wind direction, location of personnel, etc.). It is assumed that the control area location is sufficiently remote from the probable gas release area that control area personnel can immediately determine which sensor is ttiggering. Evacuation of operating personnel from the area indicating a release is always appropriate, and clearing other areas may also be necessary. Total evacuation of the test site is an extreme measure but might be necessary.

Operating personnel may have to re-enter an area with an unsafe concentration of H2S to secure equipment that if left unattended could cause additional hazards. If re-entry is necessary, appropriate Self-Contained breathing apparatus will be required.

This apparatus should only be used by those trained in its use. A "buddy **system" shall be** used **by anyone using** the apparatus. Strict **adherence to the low air** supply warning devices on the **apparatus is** required and is reinforced **by the "buddy** system."

If there are victims **that have been overcome, appropriate** first-aid can **be** applied and simultaneously, activation of the **local** emergency services network must **be** initiated to get more **advanced** medical support.

EQUIPMENT MALFUNCTIONS

False **alarms** from malfunctioning equipment are detrimental to safe operation. The alarm system must **be** trusted by the **users.** Any malfunction must be immediately corrected so that overall system confidence is restored.

Self-contained breathing apparatus should **be** checked at least weekly to verify readiness for use. Spare apparatus and replacement air tanks should be stored near the control area and protected from the elements.

BRIEFING OF NEW PERSONNEL

All personnel entering the test site and having reason to **work** in **an** area that could develop hazardous levels of **H2S** should be briefed **by** the site supervisor on the current situation, be required to read the SOPs, and signify by signature their intent to comply. Well **"sitters"** should also be fully **aware** of the requirements of this SOP and know how to activate the local emergency services network.

AUTHORIZED PERSONNEL

Signatures on the Site Signature List signify that the authorized personnel have read and agree with the content of this SOP and all appropriate addendums and will abide **by** the requirements.

SOP# 12801 8806
Orig# 4343

Addendum to
SOP #12200.8705

Safe Operating Procedure
for
Potential H_2S emissions
at the
Baca Flats Drill Site
(Specific) .

R. K. Traeger, 6250 — 6-28-88 Date

J. C. Dunn, 6252 — 6/28/88 Date

D. R. Parker, 3311 — 6-28-88 Date

D. Y. Joe, 3316 — 6/28/88 Date

D. L. Rost, 3316 — 6-28-88 Date

Prepared by:

P. C. Lysne, 6252

Hydrogen Sulfide (H_2S) is an extremely hazardous gas which is immediately dangerous to life or health at concentrations above 300 parts per million (ppm). It is easily detected by its "rotten egg" smell at a concentration of less than 1 ppm. However, the sense of smell is unreliable because of the deceptively sweet smell of H_2S at concentrations between 30 & 100 ppm and because olfactory fatigue occurs quickly.

At concentrations >50 ppm H_2S will irritate the respiratory system and can cause pulmonary edema at concentrations in the range of 200-300 ppm or greater. At a range of 50-200 ppm it is quite irritating to the eyes. At approximately 700 ppm unconsciousness will occur and death is most certain at 1000 ppm or greater. Hydrogen sulfide causes death at high concentrations through paralysis of the respiratory center in the brain.

Hydrogen sulfide is a colorless slightly heavier than air gas that tends to pocket in low lying areas or confined spaces. It has a lower explosive limit of 4.5% and an upper explosive limit of 45.5%.

Because of the potential hazards associated with H_2S it has been deemed necessary to implement the following programs for those individuals involved in core drilling projects.

A. Health hazard awareness training - H_2S
B. Confined space entry procedure
C. Self-contained breathing apparatus training
D. Emergency procedures during:

    1. - Low and High Alarms
        a. monitoring system
        b. rescue

    2. - Evacuation
        a. Contingency plan
        b. Notification

A. **Health Hazard Awareness Training - H_2S**

The introductory information to this appendix will be presented to those individuals expected to spend a significant amount of time at the drill site. It is also recommended that anyone intending to visit the drill site more than once become familiar with the information. A verbal presentation of the health hazard information will be made by a representative from Sandia National Laboratories, *Org.* 3311 or by the site manager.

B. Confined Space Entry Procedures

Anyone entering a confined space *or a* low lying area where H_2S may pocket because of little or no air movement in the vicinity of the drill site will be expected to abide by the following procedures:

1. Notify a co-worker that you will be entering a confined space (or low lying area) and have him/her serve as the standby person. This will require that he/she prepare a Scott Air Pack for rescue.

2. Establish a communications system: This could be anything from hand signals to setting up a telephone system. It will be necessary that the standby person either be in constant communication or be able to observe the person entering the confined space.

3. Discuss the purpose of.the entry plus some of the potential problems you may encounter.

4. Lock out and tag out equipment if applicable.

5. Check the confined space for H_2S, CO_2, O_2 content, and % of lower explosive limit (LEL) before entering. A concentration of H_2S > 10 ppm or an O_2 content of < 19.5% will require the use of a Scott Air Pack and a life line for entry as well as a standby *person.* Explosion-proof equipment and nonsparking tools may also be required. A carbon dioxide concentration > 5,000 ppm is unsafe and SCBA protection is required. Hand held instrumentation will be made available to make these checks.

The American National Standards Institute's document "Safety Requirements for Working in Tanks and Other Confined *Spaces"* ANSI 2117.1-1977 includes a definition for confined spaces and is as follows:

"Confined spaces are normally considered enclosures having limited means of access and egress such as, but not limited to:

(1) Storage tanks, tank cars, process vessels, bins, silos, boilers, and other tank-like compartments usually with only a manhole for entry.
(2) open-topped spaces of more than 4 ft in depth, such as pits, vaults, and vessels, not subject to good natural ventilation.
(3) Septic tanks, sewers, underground utility tunnels and pipelines, and similar structures.

C. Self-contained Breathins Apparatus Training

At least two persons trained in the proper use of Scott Air Packs shall be present at the drill site at all times. Personnel are to keep in mind that Scott Air Packs are to be used for rescue purposes and while handling an emergency. While they are not intended for continuous use while advancing a drill hole, Air Packs may be used while advancing a drill hole if it is for the purpose of bringing an emergency situation under control.

Scott Air Pack training will be provided by a representative from Sandia National Labs, Org. 3311.

D. Emersency Procedures

The last page of this document is an equipment list that includes items that may be used during emergencies.

1. Low and High Alarms

a. Monitoring System(s)

A multi-channel hydrogen sulfide monitoring system will be utilized for continuous monitoring. The system is equipped with a preset low and high alarm. The low alarm is a flashing red light set at 10 ppm* and the high alarm is a flashing light and siren set at 20 ppm**.

* American Conference of Governmental Industrial Hygienist 8-hour Time-Weighted Threshold Limit Value.

* * Occupational Safety and Health Administration ceiling value; Sandia National Lab evacuation point

Ten (10) ppm was selected as the low alarm level to warn drill operators that H_2S concentrations are at 502 of the evacuation level and that 8-hour exposures should be kept below that level. Should the low alarm be activated, the drill operator(s) is not to advance the hole unless approved by the Site Manager or the drilling foreman. Rotation and mud pumping may continue. The GRDO Site Manager must be informed and all nonessential personnel must leave the site.

The 20 ppm high alarm level was selected for several reasons:

(1) It is OSHA's ceiling value, and
(2) Primarily because above 20 ppm the odor of H_2S is very deceptive and may not be apparent to some individuals.

Should the high alarm be activated, all personnel are to retreat to a designated safe briefing station immediately. Employees returning to the work area for the purpose of bringing the situation under control are to do so only after authorization by the Site Manager.

In addition to the continuous monitoring equipment, hand held instrumentation will be available for checking O_2 content, H_2S, and CO_2% of LEL.

b. Rescue

Numerous case histories involving H_2S report one or more fatalities that occurred as a result of improper rescue attempts. For this reason, the following rules shall be strictly adhered to:

(1) Unless you know otherwise, assume H_2S is responsible for a nonresponsive individual's condition. This will require the use of a Scott Air Pack in order to rescue that individual. Do not become a victim durins a rescue attempt.

(2) Notify someone else of your rescue attempt.

(3) Move the rescued party upwind and commence appropriate first-aid.

(4) All rig and site personnel should become familiar with the prearranged plan for obtaining emergency medical care.

(5) A copy of procedures to follow during an emergency shall be posted in the briefing station(s) and in each vehicle that might be used to transport an individual to the medical facility. Emergency phone numbers and a map to the nearest medical facility shall be included.

2. Evacuation

a. Continaency Plan

All employees spending a significant amount of time at the drill site shall become familiar with the prearranged contingency plan.

b. Notification

Civilians living in the vicinity should be identified in case it becomes necessary to evacuate them. Keep in mind that high H_2S levels at the drill site may move toward these civilians. Thus, they should be informed of a prolonged emergency situation and be advised to evacuate if the wind is toward them.

Provisions to barricade the road must also be made before an emergency situation occurs.

HYDROGEN SULFIDE SAFETY PLAN
FOR
BACA FLATS OPERATIONS

Alarms: ASSESS THE SITUATION. NOTIFY SANDIA REPRESENTATIVE.

* Red Light: Comes on when hydrogen sulfide is above 10 ppm. No immediate danger, but be very cautious when entering a confined space such as the cellar or mud tank. The hole should not be advanced unless approved by the GRDO Site Manager or the drilling Foreman. Rotation and/or circulation may be maintained.

* Audible Alarm: Sounds when there is 20 ppm of hydrogen sulfide. The site should be shut down immediately and personnel should leave the area in the up-wind direction from the rig. Remedial operations must be approved by the GRDO Site Manager.

Everyone on-site should:

* Know the location of the Scott Air Packs and first-aid supplies.
* Look at the windsock occasionally.
* Know the important phone numbers.

In Case of an Emergency Situation:

* Know wind direction-check windsock.
* People not involved should leave the site.
* Scott Airpacks (buddy system) to be used to correct problem.
* Don't become an additional victim.
* If there is a victim:
  2-man plan--Assess the situation to either begin CPR or take to the hospital if victim is conscious.
  3-man plan--One person perform CPR on victim, if necessary: the other person drives to the hospital. Stopping the vehicle during the trip may be necessary to permit proper CPR to be evaluated if the road is rough.

For Very Large Emissions of Hydrogen Sulfide:

* Warn and evacuate all nearby downwind people.
* Call Sheriff's Dept.

Confined Space Entry:

* Use "buddy system"; use "trouble signs" communication system.
* Check continuous monitors.
* Inform others that a confined space is being entered.
* Ventilate area with a blower for an appropriate period.
* Use the hand-held monitor(s), holding it in front of you as you walk.

ATTACHMENT #1

Safety Equipment List for Drilling Project

1. Fans (exhaust fans, blowers,) flaxible duct
2. Air supplied respirators with 5 minute escape bottles, compressed air cylinders, hoses, regulars, wrench
3. SCBAs, spare cylinders
4. Emergency Warning Lights
5. Cable (wire for sensors)
6. Signs (warning, caution, etc.)
7. Barricades
8. Rope (to rope of areas, life line)
9. Air Streamers (wind sock, surveyors tape)
10. Lights (flood lights, flashlights)
11. Hand Pump & Detector Tubes (CO_2, H_2S)
12. Eye Wash Station (portable)
13. First Aid Kits
14. Resuscitator
15. Fire Extinguishers
16. Portable H_2S Meters
17. H_2S Calibrator
18. Batteries (g-volt, 1.5-volt)
19. Hand Tools
20. Hearing Protection, Safety Glasses, Gloves
21. Communications Systems
    a. two-way radios
        1. residents
        2. drill rig
        3. Fenton Hill
    b. telephone
        1. project personnel
        2. ambulance service
22. Tape (duct, electrical, scotch, masking)
23. Clean wipes

This Document was
prepared by J. N. Gardner
Los Alamos National Laboratory

SCIENTIFIC CORE HOLE VC-2B: FIRE PLAN

(modified from Title 5100, U.S. Forest Service)

Included Activities - The objectives of these general provisions are to provide and establish guidelines related to all activities of the VC-2B Scientific Drilling Project at Baca Location #1, New Mexico.

Involved parties include: The Valles Caldera Scientific Drilling Team, headed by Chief Scientist/Principal Investigator, Dr. Jamie N. Gardner of Los Alamos National Laboratory; the Geoscience Research Drilling Office, headed by Chief Engineer, Dr. Peter Lyme of Sandia National Laboratories; and the OWNERS of Baca Location #1, New Mexico.

A. FIRE PREVENTION

1. Execution

a. The Chief Scientist and Chief Engineer are designated as fire plan representatives who shall be responsible for executing and carrying out the applicable fire requirements.

b. The fire plan representatives shall assure that all their employees are informed of the existence and conditions of the fire requirements.

2. Inspection Requirements

a. The *fire* plan representatives or their designated fire guard (Section A-8) shall make daily inspections to ensure that the items of the fire requirements are met at all times.

3. Equipment Requirements

8. All internal combustion engines mounted both internally and externally shall be equipped with a spark arrester qualified and rated under U.S.D.A. Forest Service Standard Spark Arrester Guide, 5100-1A, unless it is:

(1) Equipped with a turbine-driven exhaust supercharger such as a turbo-charger. There shall be no exhaust bypass.

(2) A passenger carrying vehicle, light truck, or medium truck used on roads and designated parking areas only and equipped with a factory designed muffler and exhaust system, in good working order.

(3) Heavy duty trucks, such as dump trucks, or other vehicles used for commercial hauling used only on roads and are equipped with 8 factory designed muffler and/or with a vertical stack exhaust system extending above the cab.

b. A ● ultipouition engine such u on power saws purchased after June 30, 1977, which must meet the performance levels set forth in the society of automotive engineers, 'multipositioned small engine exhaust fire ignition standards, SAE recommended practice J335B," u now or hereafter amended. Those purchased prior to the above date shall be equipped rith an 8pproted spark/arrester/muffler containing 8 0.023-inch mesh in good serviceable condition.

c. All exhaust equipment including spark arresters and mufflers shall be *properly* installed and constantly maintained in serviceable condition.

d. Fuel trucks or any other heavy duty trucks shall be equipped with a long-handled round pointed shovel and one ABC chemical fire extinguisher *of* not less than 5 pounds capacity.

e. Passenger carrying vehicles making routine visits to the site, including light trucks, shall be equipped with one long-handled round pointed shovel and one ABC chemical fire extinguisher not less than 2-1/2 pounds capacity.

f. All crawler tractors, front end bucket loaders, and skidders shall be equipped with an ABC chemical fire extinguisher, not less than 5 pounds capacity.

g. Equipment service areas and gas and oil storage areas shall be cleared of brush, litter, grass, or other flammable debris for a radius of 50 feet.

4. Welding

a. An area of 10 feet or more clearance shall be cleared down to mineral soil before welding operations are started. Minimum equipment shall consist of a round-pointed long-handled shovel, a minimum five-gallon reservoir pump filled rith water, in addition to a five-pound fire extinguisher at each relding site. The area adjacent to the relding operations shall be thoroughly checked for *fires for* one hour after relding is completed. Welding operations are restricted under Fire Precaution Plans C and D.

5. Cable Yarding

8. Tail and corner blocks shall be located to prevent cables from rubbing against trees, snags, and down logs. Areas adjacent to tail and corner blocks shall be cleared of flammable material within 8 five-foot radius.

6. Smoking and Fire Restrictions

8. Specific Fire Precautionary Yeuures. Smoking out of doors (restricted under Fire Precaution Plans B, C, and D) will be 8llored only in *areas* designated by the *fire* plm representatives. Building *of* open *fires* sill not be allowed.

b. *No refuse, slash, or* other debris shall be burned.

7. Fire Guard. During periods when the Fire Prevention Plan is Plan B, Plan C, or Plan D, the Fire Plan representatives will designate fire guards. A fire guud sill be at each operating area where power driven equipment has been operated during the day. The fire guards shall constantly perform their duties during operating hours and *for* three hours after any stoppage of *work* when the Fire Precaution Plan is Plan C or Plan D.

Fire guud service on one operating area shall satisfy the requirements on adjacent areas *if* the travel time with available transportation is not in excess of 10 minutes to any of the other areas requiring such services.

Each fire guard shall be physically able and vigilant to prevent, detect, and report any fires and to promptly and efficiently take suppression action with available required firefighting equipment and men on any fire that starts on operations uta.

8. Historical Data. The following data on the Santa Fe National Forest area were provided by the U.S. Forest Service in Jemez Springs in 1984. The data are based on records *for* at least the prior 10 years.

Total fire season May 15 to July 30th

Average number of days of Plan A *22*

Average number of days of Plan B *30*

Average number of days of Plan C 14

Average number of days of Plan D 10

B. PRESUPPRESSION

Fire tools sill be on-site to be used only *for* suppressing fires as follows: cutting edges sharp, handles sanded and tightly fitted, clear of rust and foreign material, and properly muked.

The operation shall be provided with six firefighting tools to equip each of the personnel normally engaged in the operation.

Approved firefighting tools include puluki, McLeod, brushhook, and round-pointed long-hurdled or lady shovel.

These *fire* tools shall be located in the active area of activity.

C. SUPPRESSION

Independent action on the suppression of all fires in the work area or vicinity sill be initiated by project personnel.

All *forest* fires shall be reported to the Owners and to the District Forest Ranger's *Office* as *soon* u possible. Even though the fire has been suppressed by the operations crew, this report is required. The *office* . and telephone number to which fires shall bt reported will be posted near all on-site communications equipment.

D. EMERGENCY FIRE PRECAUTIONS

Operator will restrict operations in accordance with the attached Emergency Fire Precaution Schedule. The U.S. Forest Service shall, each day of optration when there is a predicted change in Fire Preuution Plan, inform the VC-2B site between 3:00 P.M. and 6 P.M. (MST) 4:00 P.M. and 7:00 P.M. MDT) of the alphabetical Industrial Precaution Plan to be followed the next day within the local operating area. Forest Service shall, no later than 9:00 A.M. MST (10:00 A.M. MDT) the following day, advise the site of a change in the Fire Precaution schedule.

EMERGENCY FIRE PRECAUTION PLAN SCHEDULE

FIRE PREVENTION PLAN	DESCRIPTION
A	Normal fire precautions, must meet requirements as described in *A* - Fire Prevention, B - Pre-suppression, and C - Suppression, except that A, 8 Fire Guard is not required.
B	Normal fire precautions, except smoking out *of* doors (Section A-7-a) allowed only in designated areas cleared to mineral soil.
C	Machine treatment of slash, skidding, cable yuding, blasting, welding, metal cutting, clearing, and loading will occur in an area, sprinkled with water to maintain *a* dampcondition, during the activity. Fire guard service is required *for* three hours after these activities. Out-of-doors smoking permitted only in designated areas cltutd to mineral soil. Optrations on mineral soil involving road excavation, watering, grading, surfacing, rock crushing, and/or other equipment maintenance may continue.
D	*Area of* 100-foot radius of &ill rig and other operating machinery will bt sprinkled with water frequently enough to maintain a dup condition. Out-of-doors smoking prohibited. A minimum of 1000 gallons of water for the sole purpose of fire suppression will be maintained at the site. Activities on mineral soil involving rod excavation, wattring, grading, gravel surfacing, and rock crushing may continue. All machine treatment *of* slash, skidding, cable yuding, welding, metal cutting, clearing and loading will bt shut down from 12:00 Noon until 8:00 P.M. MST (1:00 P.M. to 9:00 P.M. MDT), and will only be

allowed in the sprinkled area. Vehicle6 will be allowed only in sprinkled areas, or ueu of exposed gravel or mineral soil.

SCIENTIFIC CORE HOLE VC-2B:

ECOLOGICAL DAMAGE, MITIGATION AND RESTORATION PLAN OUTLINE
(modified from Olinger, HSE8-87-782,
Action Description Memo for Scientific Core **Hole VC-2B, Valles Caldera)**

I. **INTRODUCTION:**

Purpose, project, involved **parties,** and the **site.**

II. **POTENTIAL ENVIRONMENTAL AND CULTURAL RESOURCE IMPACTS AND MITIGATION EFFORTS**

A. **Cultural resources**

B. **Earth moving**

C. **Noise**

D. **Pollutants**

1. **Liquids**

2. **Gases**

3. **Spills**

III. **RESTORATION**

I. INTRODUCTION

This plan provides an outline of anticipated potential environmental impacts of the VC-2b Scientific Drilling Project (Figure 1) at bsca Location Mo. 1, Nev Mexico, with diacusaion of measures to be taken to minimize and/or mitigate these impacts, and steps to be taken to restore the site upon capletion of the project. Operational aspects of the project, with the cooperation of the OWNERS of the Baca Location No. 1, are headed by Chief Scientist/Principal Investigator Dr. Jamie N. Gardner of Los Alamos National Laboratory, and by Chief Engineer Dr. Peter Lysne of Sandia National Laboratories. The VC-2b project is psrt of the larger national program of U. S. Continental Scientific Drilling which seeks, with the use of the drill as a scientific tool, to answer fundamental questions of social and national security significance regarding the continents on which we live.

VC-2b will be a continuously cored hole to depths of 6000 to 7000 feet. To tchitvt these depths, the drilling contractor will utilize a rig known as a Universal 5000 in round-the-clock operation for as long as four months. The Universal 5000 is large by diamond coring industry standards, and will require concrete pads and/or footings to maintain both ground and rig stability. Additionally, VC-2b will penetrate an active, high temperature geothermal system, and although unlikely, if geothermal fluids begin to flow during drilling the site must be prepared so as to contain these fluids. The specific spud site for VC-2b and the physical layout of the site support facilities, art the result of consideration of many factors such as: scientific objectives of the project, environmental impact, safety, ground stability, and practical logistics. Many aspects of the environmental considerstiona • ecotmaodattd in the site design are discussed below.

Table 1: Plants identified at the VC-2B project site.

COMPOSITAE
- Achillea lanulosa
- Taraxicum officinale

CYPERACEAE
- Various sedges

FAGACEAE
- Quercus gambelii

GRAMINEAE
- Various meadows grasses

IRIDACEAE
- Iris missouriensis

LEGUMINOSAE
- Robina neomexicana
- Trifolium spp.
- Vicia americana

PINACEAE
- Picea pungens
- Pinus ponderosa

POLYGONACEAE
- Rumex spp.
- Rosa spp.

ROSACEAE
- Potentilla spp.
- Rose spp.

SALICACEAE
- Populus tremuloides
- Salix spp.

SUNFLOWER FAMILY
- Yarrow
- Dandelion

OAK FAMILY
- Gambel oak

IRIS FAMILY
- Wild Iris

PEA FAMILY
- New Mexico locust
- Clover
- Vetch

PINE FAMILY
- Colorado blue spruce
- Ponderosa pine

BUCKWHEAT FAMILY
- Dock

ROSE FAMILY
- Cinquefoil
- Wild rott

WILLOW FAMILY
- Aspen
- Willow

Figure 1 • houe the location of the site and • detailed • ketch map of the site layout. The VC-2b site is • large open area that was leveled on the toe of an ancient landslide complex in the • ♌❒●♋ 1960's for the drilling of two geothermal wells (Baca-1 and Baca-3). Vegetation is typical of dirturbtd areas in mixed conifer forest ♋♦ • levetioaa above 8000 feet. Table 1 shows a list of plant • peciem identified at the site in • survey by botanist T. S. Foxx (Lo8 Alamos) performed in May, 1987. Foxx did not identify grass and sedge species because of tht • trly spring season *tnd* lack of flowering structures used in taxonomy. Wild animals, as identified by droppings, at the site are dominantly transient deer, elk, tnd black bear. No rare, threatened, or endangered species vtrt nottd.

II. POTENTIAL ENVIRONMENTAL AND CULTURAL RESOURCE IMPACTS AND MITIGATION EFFORTS

A. cultural Resources: Consulting • rchatologist Bevtrly Larson, on contract with Los Alamos, surveyed the VC-2b site and surrounding areas in Junt 1987. No cultural resources art located within the area that will be affected by the core drilling operations. The proj tct site was extensively disturbed in the early 1960's for tht drilling of geothermal well8 Baca-1 and Baca-3. Well heads for each *of* these wells remain at the site. Because the operation is on private land, consultation with the New Mexico State Historical Preservation Office is not required undtr Section 106 of tht Historical Protection Act of 1966.

B. Earth Moving: The nature *of* tht core drilling rig and operations, as well as considerations of ground stability, loading, and safety will require earth moving (excavation8 and/or filling) at the site including the following: mall scale drill rig pad about 65 fttt x 45

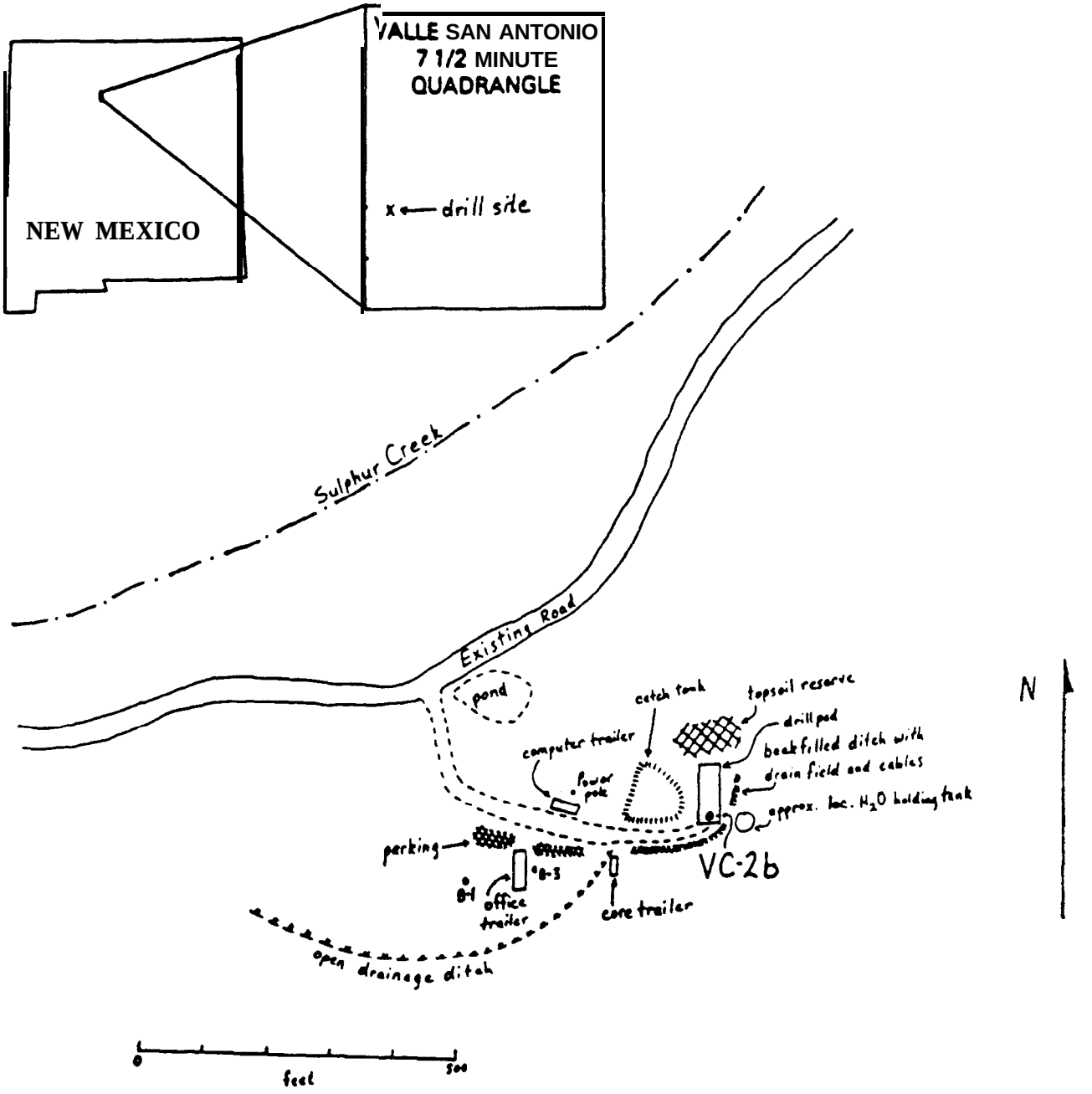


Figure 1: Location of VC-2b project site with detailed sketch map of drill site.

feet, cut several feet below grade, backfilled w/gravel and compacted; drainage ditches and culverts; access road to drill rig, compacted gravel about 20 fett wide, 200 yard8 long; trick tank for emtrgtncy fluid catchment, bermed end cut on natural slope; and, well-htad cellar less than 4 fett deep. Figure 1 shows the areas that will bt affected by there activities. Most earth moving will bt done with 8 relatively small bulldostr, btck-hoe, and/or grader. Care will bt taken by equipmtnt operators to minimize the areas disturbed, and top soil will be reserved for rtdirtribution during restoration. Impact of earth moving • ctivitie8 will be very localized, and will destroy plant life in affected areas. Drainage will be • ngineered to rttard troeion of top soil and to prtvent reactivation of tht landslide. Additionally, drainagt systems will bt designed to kttp operational areas as d r y as possible, and to conduct any geothermal fluids to catchment and/or scrubbing facilities.

C. Noise: Noise levels will not excttd the 110 decibel (dB) limit recommended by the U.S. Fortst Service. Los Alamos Health Safety and Environment staff will monitor noise levels on start up and engines will be additionally muffled, if necessary, to meet the 110 dB limit. Environmental impact of noise will be extremely local and short-term, and will *affect* mainly wildlife roaming in the site vicinity. However, ample subdued topography • xi8t8 nearby to allow normal • nioml passage through the • reA and ready • cce88 to water sources.

D. Pollutants: Possible environmental pollutant8 • [illegible] with the VC-2b project include gas and liquid • mi88ion8. Gas emissions, othtr than diesel engine • xh8u8t, would be geothermal gases. Liquid8

consist of drilling mud, and additives, and geothermal waters. Table 2 shows ● Mly8e8 of typical geothermal fluids from this area, 88 well • 8 tht range of natural chemical compositions of waters from the Sulphur Creek drainagt. Portable toilet facilities will bt used and no sanitary effluent8 will be gtnerated.

1. Liqufd8: Thecoring rig will utilize a self-contained mud tank-mixer-sump system. A blw out prtvtntion stack, 8tandard for drilling in geothermal • rta8, will control or prevent tht flw of gtothtrmal fluid8 encountered during drilling. In addition, diamond coring requirtt a column of drilling mud bt maintained in the holt; ● xptritnct fromall drilling in tht project area 8hovs that formation pressures of geothermal ● quiftr8 are invaritbly sub-hydrostatic. Thus, tht drilling mud in tht hole will serve to inhibit up hole flw of geothermal fluids.

If the drilling mud should escape the integrity of its self- contained system, or if geothermal fluids should began to flw in extremely large volumes, 8 primary tmtrgtncy catch tank of approximately 50,000 gallon capacity will be bermed 8nd cut on natural slope immediately downhill from the coring rig. This primary catch tank will bt lined to prevent contamination of the soil and facilitate clean up should it8 use ever be requirtd. A8 secondary backup to the catch tank, a pond about ont-quarter mile down-drainage from tht drill site, originally constructed as catchment during tht drilling of Baca-1 and Baca-3 in the early 1960's, will be drained and refurbishtd to about 50,000 gallon capacity. As tertiary backup for the fluid containment system, Lake Corbin at Sulphur Spring8 could be drained to accommodate over 100,000 gallons. Lake Corbin servedas tht primary catch tank for the drilling of VC-2a in 1986 and was also part of the original Baca-1/Baca-3 catchment system.

Table 2: Chemical analyses Of natural fluids in the Sulphur Creek drainage and one sample of deep geothermal fluid from well Baca-13. Sample S-9-81 was collected from a locale where a gaseous spring issues into Short Canyon creek.

	Gaseous Spring Short Cnyn.	Bubbling Pool Alamo Cnyn.	Sulphur Btct #13 Crttk	
Sample:	S-8-8 1	VA-22	S-l 1-81	BA-1
Date:	8/81	3/79	8/81	6/82
Temp., °C	15	0.5	16	278
Flow, l/min	1	8	120	—
Field pH	2.48	4.5	6.61	7.30
Field Eh, mV	4 5		-8 5	75
Lab Conduc., µS/cm	1990	280	690	8500
SiO_2	70	44	44	640
Al	6.4	—	0.04	0.003
Fe	7.85	1.37	1.36	0.07
Mn	0.37	0.30	10.6	<0.01
Ca	58	14.1	95	3.5
Mg	7.85	2.75	12.8	0.01
Na	8.0	5.8	20.0	1550
K	7.6	4.5	13.2	255
Li	0.04	0.02	0.06	22.6
NH_4	<0.1	—	<0.1	2.0
HCO_3	0	0	47.6	221
SO_4	517	109	238	49
Cl	7.8	4.9	9.6	2500
F	0.31	0.23	<0.10	9.4
Br	<0.1		<0.1	7.00
NO_3	<0.1		<0.1	<0.1
PO_4	<0.1	—	<0.1	<1.0
H_2S (dissolved)			<0.05	0.21
B	<0.01	<0.01	<0.01	19.6
Ba	0.04	co.12	0.05	0.02
CU	<0.01	co.04	<0.01	0.02
Ni	0.03	co.05	<0.01	0.03
Pb	<0.01	<0.14	<0.01	0.05
Sr	0.26	0.40	0.30	0.21
Zn	0.07	<0.01	0.04	<0.01
As	<0.16		co.13	1.52
Hg	co.13		<0.17	<0.15

Lake Corbin was never needed for catchment during drilling of, *flow* tests of, □□ • ⊠□ℳ□ℋ○ℳ♋♦☝ on VC-2a.

Commonly in diamond coring operations in volcanic areas, drilling fluid circulation is lost for extended period8 of time. Drilling mud is pumped down the hole and instead of returning to the surface it passes into permeable formations. Thus although highly unlikely, we do acknowledge some concern that drilling fluids lost downhole could possibly leak into and contaminate natural waters. Consequently, throughout the duration of the drilling project we will maintain a program of environment81 monitoring of the chemistry of selected springs 8nd natural waters in the area for any contaminants resultant from the drilling operation. A8 tentatively identified, the fluids that will be routinely (biweekly) sampled and ● nalyzed are as follows: Sulphur Creek about one-quarter mile upstream from the drill site; gas from Baca-3; drinking water cistern on the Sulphur Creek road about one-quarter mile down slope from the drill site; Footbath spring at Sulphur Springs; Sulphur Creek about 100 yards downstream from Sulphur Springs; 8nd Soda Dam spring in San Diego Canyon. With our analytical facilities detection of any contamination of natural waters will be sensitive in the parts per million or parts per billion concentration range, at concentrations much lower than those permitted by Federal and State regulatory● gencies. Should any such contamination of natural waters be detected, drilling operations will be suspended until lost circulation conditions can be remedied and the pathway of contamination severed.

2. Gases: Hydrogen sulfide gas • mm8te8 naturally in the project vicinity. It is likely that some flw of H_2S in formation vapor will be encountered during drilling from depth8 of 30 to *800* feet. However, the volume of H_2S is very low (less than 1.5% of total gas), and tolerance level8 dictated by site personnel safety are far below environmental regulatory limits. During

drilling an extremely sensitive H_2S detection system, with sensors placed at several localities in the drill site vicinity, will operate contiuously. The detection ● ⍰❍◆ℳ❍ will automatically trigger high alert alarms if any sensor reads 20 ppm H_2S. During high alert, the drill rite will be evacuated of ● 11 nonessential personnel and operations will be suspended until the flow of H_2S is stopped or widespread concentration is brought below the 20 ppm limit. Additionally, 8 blooey line will be connected to a wierbox/scrubber that will, with a slow drip of H_2O_2, remove 811 H_2S from controlled flow.

After completion of drilling, large fluid entries will be flow tested under controlled conditions for short period8 of time because of their scientific importance. During these tests, H_2S monitoring will be done vith small portable detectors. Liquid8 produced during there testswill be monitored on site for key chemical species. When pollutant concentrations in the diluted ● ffluent, if any is produced, at the closest point of Sulphur Creek reach levels of about one-tenth of the Environment81 Protection Agency's limits for livestock water, the flow test will be terminated. The wierbox/scrubbing apparatus will be used in all flow tests.

3. Spills: It is possible that during drilling spills of diesel fuel, mud additives, or drilling mud will occur in the immediate vicinity of the drill rig. These spills would be extremely small volume and very localized.

III. RESTORATION

After completion of drilling the rite will be jointly inspected by representatives of the project leaders and the Manager of the Baca Location No. 1. The designated inspectors will complete end sign a Site Restoration Check List to cover those restoration ● ctivitie8 necessary at that time. After completion of flow tests and other experiment8 in the core hole, 8 second

inspection by the same inspectors will produce a Final Site Restoration Check List to cover final rite abandonment and restoration. We discuss restoration in this section in conditional and general terms only because the OWNERS may wish to preserve and utilize some aspects of the site, 8uch a8 the core hole itself, road, catch tanks, etc. Otherwise, it is the intention of the project leader8 to restore the mite to the condition in which we first found it as much 88 is possible.

In general, excavation8 will be backfilled to approximate original contours, compacted, covered with reserved top soil and reseeded with grass seed. Liners in catch tank8 will be removed prior to backfilling, and any contaminated soil will be scraped up and disposed of at the approved waste dump at Fenton Hill, then replaced vith reserved top soil and reseeded. Filled areas, such a8 roads, can also be scraped up and replaced with reserved top soil. Concrete will be pulled up and removed, if practical; othervise, concrete will be buried at least three feet below restored ground surface. The entire site will be reseeded.

Following completion of scientific flov tests VC-2b can be abandoned. The hole vould be plugged with cement, and the well head cut off several feet below ground surface. A cap would be put on top of the pipe and it would be buried. Ensuing restoration vould be the same as for other excavations at the site.

AIR EMERGENCY SERVICES
LIFEGUARD

HOW TO CALL LIFEGUARD

1. Through local dispatch
2. Through Santa Fe Control or
   Medical Channels
3. 1-800-MED-LIFT (1-800-633-5438)

GENERAL GUIDELINES FOR CALLING

1. Unconcious victim/Life threatening injury
2. Multiple victims
3. High speed accident
4. Transport time in excess of 26 minutes
5. Prolonged extrication
6. Advanced life support crew required

1-800-MED-LIFT

HELICOPTER PROTOCOL

1. LANDING ZONE (60 ft. radius, fairty flat)
   **RESTRICT PERSONNEL
   and VEHICLES**
   -Free from obstacles and overhead wires.

2. RADIO
   -Monitor for contact with LIFEGUARD 1.

3. APPROACH HELICOPTER ONLY:
   -With pilot's OK
   -From the FRONT.
   -From DOWNHILL position.

4. **NEVER**
   *GO TOWARDS TAIL of HELICOPTER!
   *LIFT ANYTHING OVER YOUR HEAD!
   *SMOKE!

CAUTION-BLOWING DUST and DEBRIS

AIR EMERGENCY SERVICES
LIFEGUARD

SAFETY PROTOCOL
HELICOPTER LANDING ZONE

LANDING ZONE PREPARATION

1. Minimum 60 ft. radius.
2. Fairly flat (no excessive slope).
3. Free from overhead wires.
4. Remove large objects that might be picked up by the rotor system. (Examples: plastic bags, sheet metal, plywood, etc.)
5. Note obstacles which are near the landing zone.
6. At night:
    a. Shine spotlight on obstacles such as nearby power line poles or trees.
    b. Do not shine lights into cockpit.
7. Restrict movement of personnel and vehicles into the landing zone.

OPERATIONS

ETA: 5-10 MINUTES:

The pilot will establish radio contact either on a prearranged frequency or one you give during your initial call for LIFEGUARD I.

Information needed:

a. Location of the landing zone.
b. Obstacles near the landing zone.
c. Winds

Example: "Land in the east bound lane between the ambulance and patrol car. You have power lines on the south side of the highway. Winds are from the north at approximately 10 mph."

LIFEGUARD 1 ON APPROACH:

1. Restrict movement of personnel and vehicles into the landing zone.

2. Insure that no lights are allowed to shine into the cockpit of the helicopter.

3. Landing Guide (optional).

   a. Arms straight out towards center of LZ.
   b. Back to the wind.
   c. Facing the landing zone.

LANDING:

1. Landing Guide should move away from the landing zone. As soon as helicopter comes to a hover, turn and move away.

2. All personnel in close proximity to the landing zone should protect themselves from blowing dust and debris caused by the helicopter.
   Close all vehicle doors--especially the ambulance.

LIFEGUARD 1 ON THE GROUND:

1. Maintain the security of the landing zone.

2. **NEVER** go toward the TAIL of the helicopter.

3. Approach the helicopter only if necessary.

4. Before approaching the helicopter, secure all loose items, e.g., hats, paperwork, etc.

5. Approach helicopter only after pilot's okay. (Pilot will give okay by hand signal or on radio.

6. Approach: only to the front--only uphill.

   Depart: only from the front--only downhill.

7. No smoking within 100 feet of the helicopter.

a. No running within 50 feet of the helicopter.

9. **NEVER** lift anything over your head when under the rotors.

10. No vehicles within 30 feet of the helicopter.

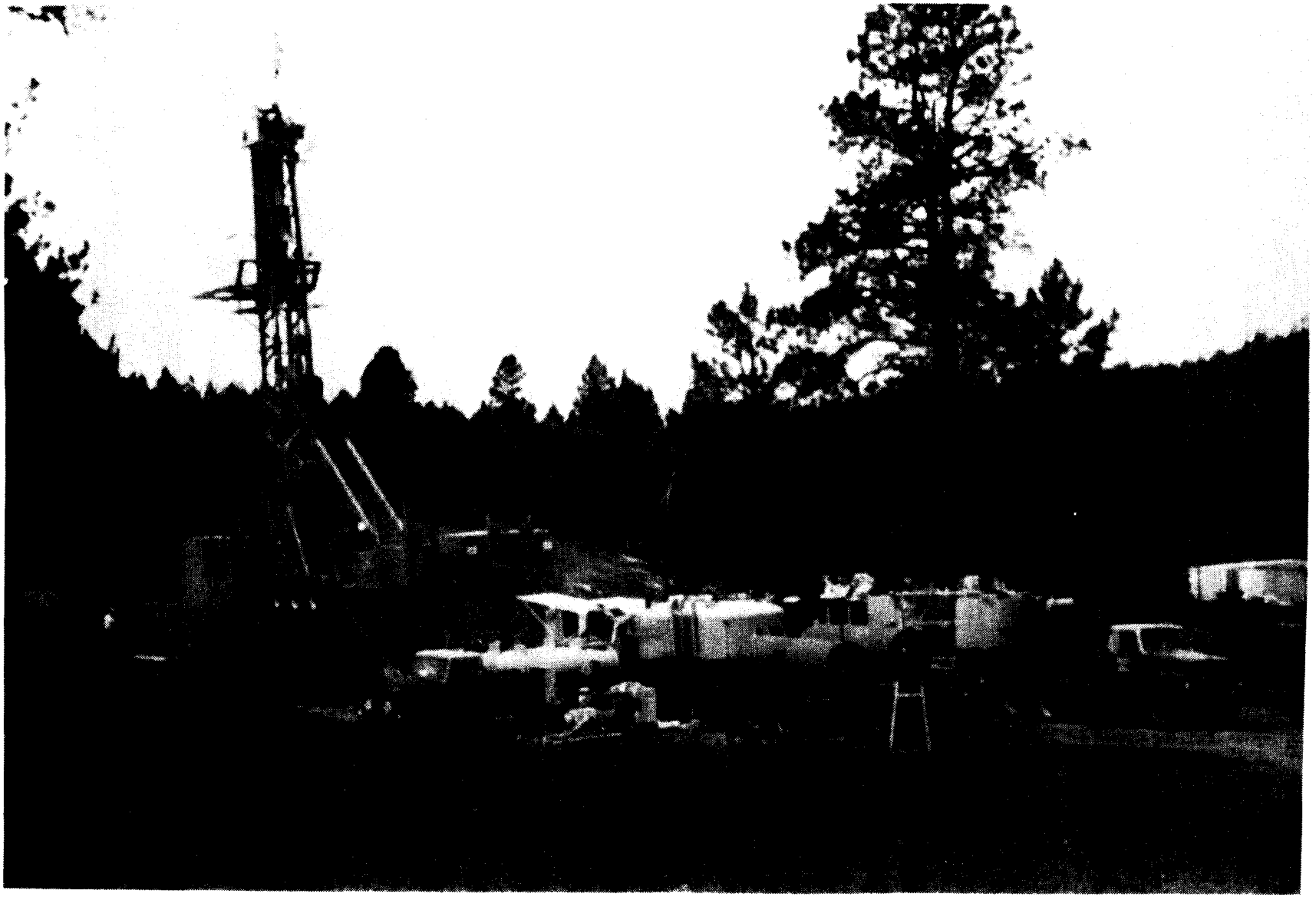
11. **FLIGHT CREW MEMBERS ONLY** will operate the doors.

APPENDIX C

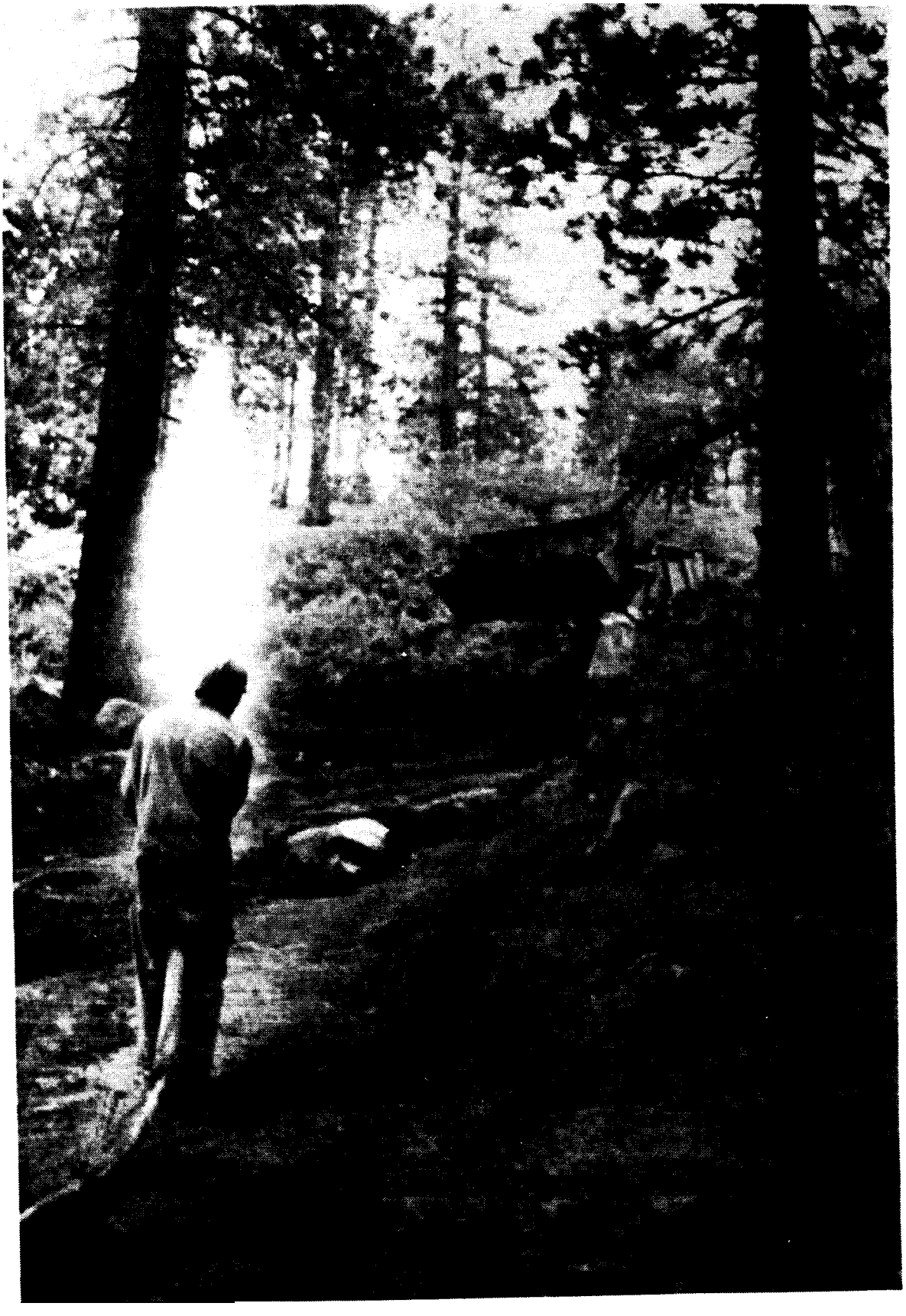
PHOTOGRAPHS OF SEVERAL FIELD OPERATIONS

VC-2B:	Aerial view Heavy equipment activity
INYO 4:	Road building Pad congestion Safety training
Quarry OPS:	Site overview Equipment activity

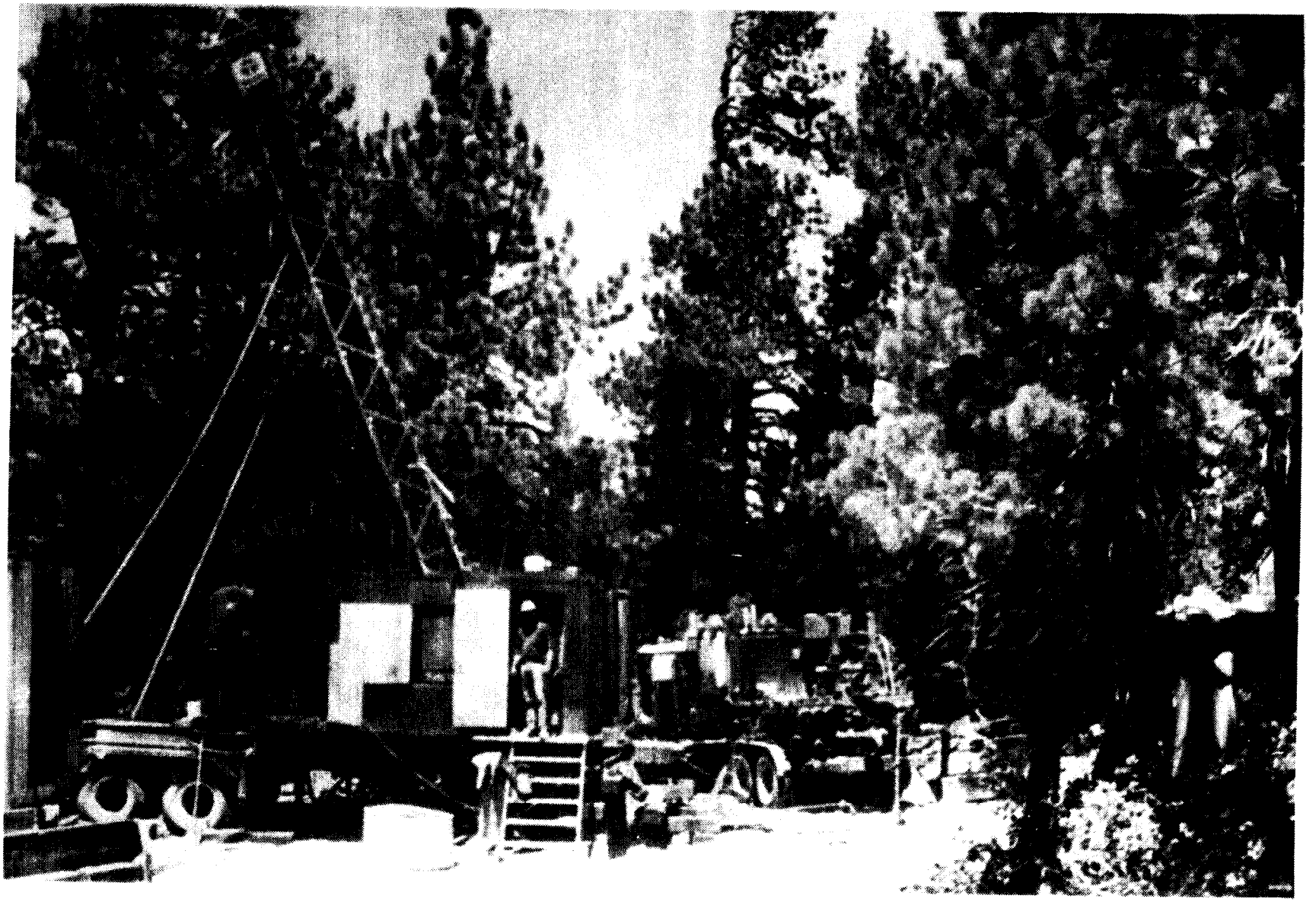
Aerial view of VC-2B



Heavy Equipment Activity at VC-2B

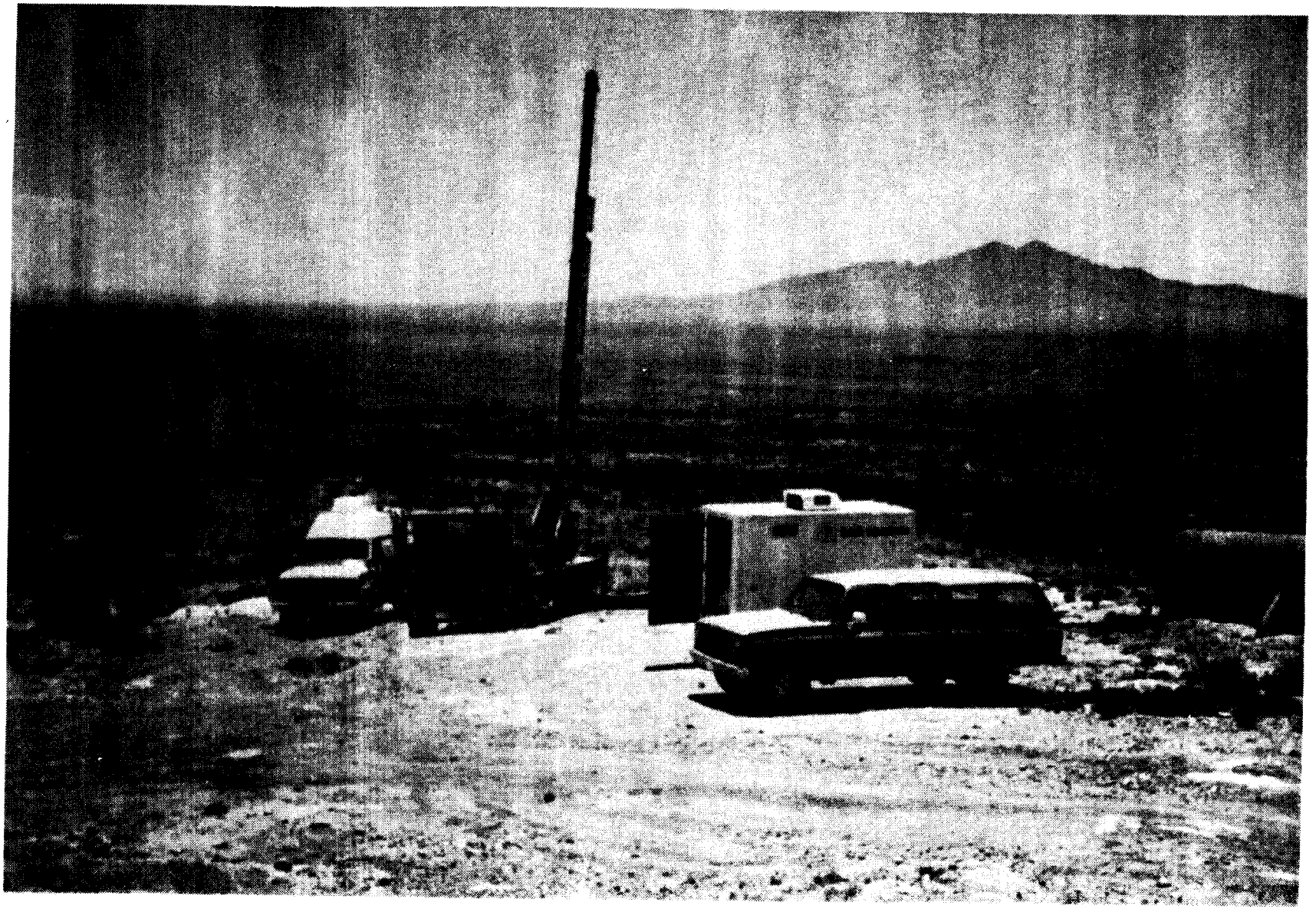


Road Building (INYO 4)

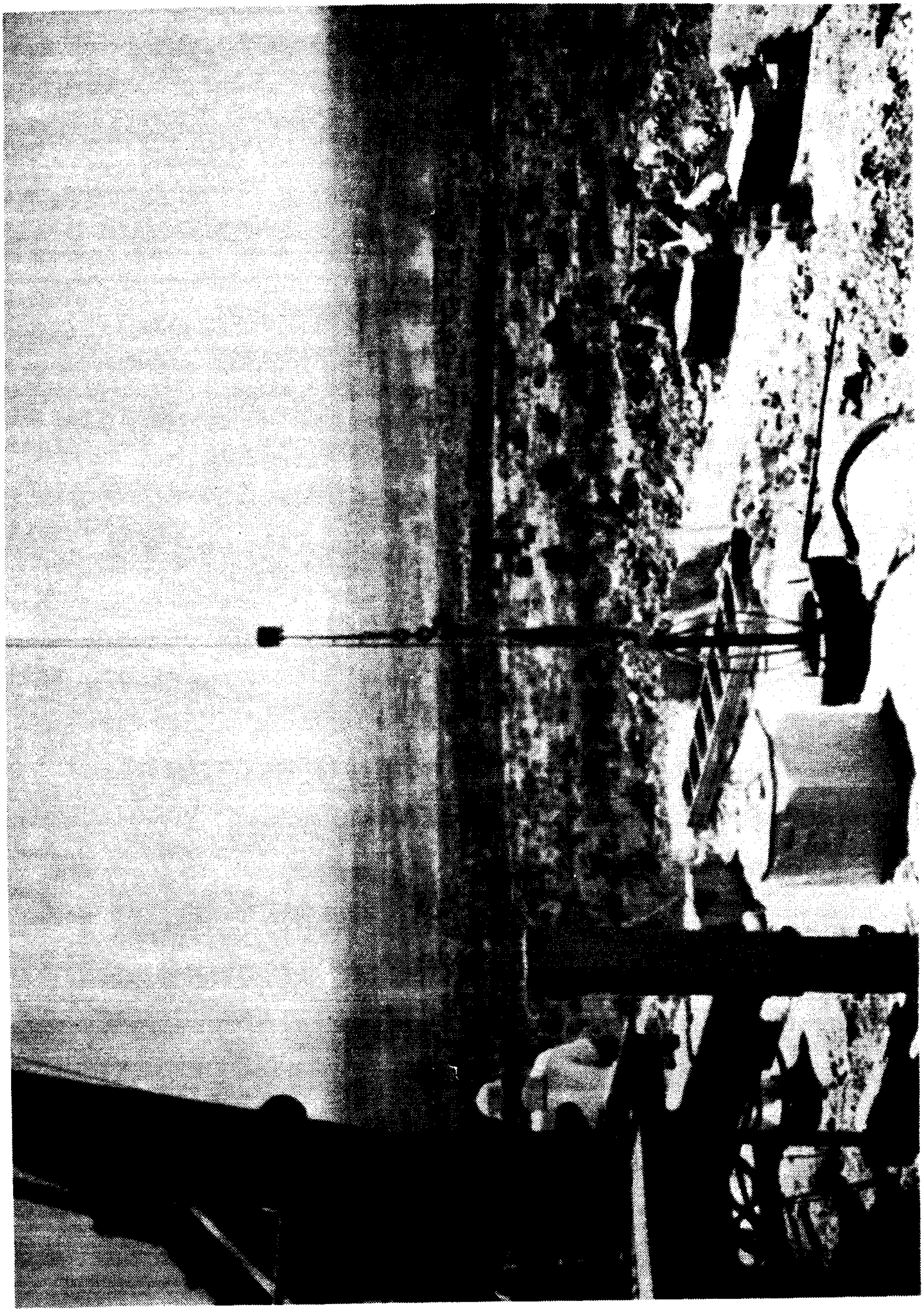


Pad Congestion (INYO 4)

Safety Training (INYO 4)



Site Overview (Blen quarry)



Equipment Activity (Belen Quarry)

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